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# GREEN WIEGHT

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## ABSTRACT

Green-weight is a novel system designed to supply a high-rise building with all its needs of electricity using wind energy and to supplement its lighting needs with natural sunlight. David Fisher has proposed an ingenious method to harness the wind for electricity production in an urban setting. His approach is based on using horizontal wind turbines instead of the typical and esthetically awkward looking vertical wind turbines and to incorporate them within the building structure. In this paper we will present our proof-of-concept study of the proposed system. Based on our prototype design of the wind turbines and overall system analysis. In the second part of our paper we will present our proposed auxiliary lighting system. Our system is designed to collect and transfer the sunlight into the building. We estimate that our auxiliary lighting system will save between 40 to 60% from the power needed to light the building during daytime. Another very importantly aspect of our lighting system is the proven fact that natural lighting enhances the living experience of the building occupants (for example, to combat psychological seasonal disorders).

## INTRODUCTION

The shortage of electricity in Kuwait and global warming effect inspired us to find a new way to use alternative energies to implement it in high-rise buildings. We decided to create a project. This is a proof-of-concept of green building that uses wind to generate its own energy and hybrid lightning to support its lighting throughout the day.

The system is divided into two parts, the wind turbines and the lighting system.

The concept of wind turbines between the floors of the high-rise buildings is an architectural idea done by David Fisher (Fig.1). The Moda Mall (Fig.2) in the Kingdom of Bahrain is an example of a building that uses these wind turbines. The main differences being that in this case, they are implemented on a horizontal axis between the two towers, there are only 3 wind turbines for the whole building, and they are noticeable. On the other hand, in David Fisher's concept the wind turbines are set on a vertical axis, with a wind turbine for every floor, and they are hidden between the floors of the building.

A study has been done showing how to increase the flux inside the fiber optics. Another concern was about making the dish last longer through dust penetration and other forms of extreme weather.

As a part of our proof of concept we constructed a small-scaled model that demonstrates how the two different systems work.

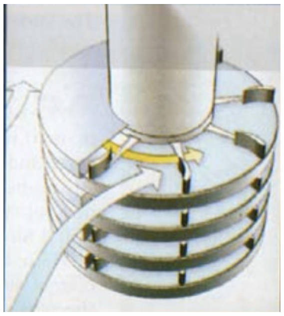

Fig 1: Wind Turbines in David Fisher's Idea [1]

Fig 2: Wind Turbines in Moda Mall

<u>Part 1: Wind-Turbine System</u> The main idea of David Fisher is the dynamic architecture or the dynamic building. Part of his idea is to use the wind turbines between the floors, which we designed in our project, to be suitable for most of the high-rise buildings.

The design of the wind turbines will consist of eight blades set horizontally on a vertical axis between the
floors of high-rise buildings. These will be 14 meters in length, 80 cm in height and the thickness of them will depend on the strength of the wind in each height (Table. 1). Through the rotation of the blades they will supply two generators in each floor, resulting in a total of 140 generators for the whole building. The electrical energy from the generators will be saved in batteries. Finally, the acoustic issues can be also solved by using Damping systems i.e. noise and vibration.

In our proof-of concept we found that a 70 wind turbines are capable of producing an average of 20 MW per year. The wind-turbine system will provide all the electricity needs of the building, estimated around 5 MW per year, and the excess energy generated by the system will be sold back to the grid. Depending on the civil aviation's wind readings and by using the Beltz equation:

$$P = \frac{1}{2} \cdot \rho \cdot S \cdot v_1^3 \cdot C_p.$$

[2] Where P = Power. ρ = Density of Air. S = Surface Area. Cp= Coefficient of Performance

| Height | Thickness |
|---|---|
| 50m-150m | 13mm |
| 150m-250m | 19mm |
| 250m-350m | 22mm |
| 350m-450m | 28mm |

Table 1. Thickness of the blades

<u>Part 2: Lighting System</u> The design of the lighting system consists of four parts (Fig.3): Primary Mirror, Secondary Mirror, Tracking System, and Optical Fibers. The primary mirror directs the sunlight to the secondary mirror, which then concentrates the sunlight to the fiber optics. The tracking system makes the primary mirror follow the sun throughout the day. In the paper published by Feuerman, Gordon, and Huleihil it demonstrated that they can transfer the sunlight through the fiber optics to a distance of 20m.

The goal of our project is to increase the distance of transferred sunlight in order to suffice the height of the high-rise building.

A mixture of plastic and acrylic is used in the making of the primary mirror in order to reduce costs and bear high temperatures. The secondary mirror strips the UV and IF in order to reduce the heat. It then focuses sunlight to the tips of the fiber optics. These fiber optics consist of 2 kinds of fiber: The first kind is a high quality fiber with low alpha in order to preserve more energy, and the second kind is a lower quality fiber that has high alpha in order to scatter the light in the places that need lighting. We can express the alpha in the following equation:

$$\frac{P(z)}{P(0)} = e^{-\alpha z}$$

[4] Where α denotes a given number provided by the factory, and z denotes distance in meters

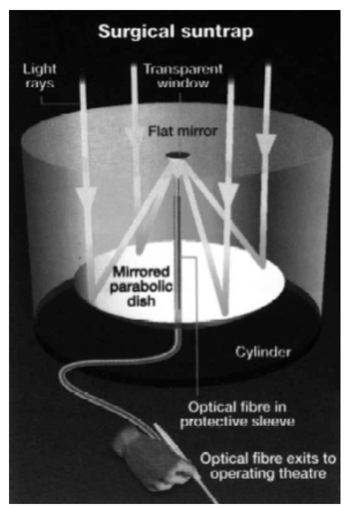


Fig 3: Lighting System [3]

CONCLUSION

The distinctiveness of our project is that we integrated both sun and wind energy to supply a high-rise building with its energy needs. We used the sunlight in a unique way in order to illuminate our building throughout the day, which will also save us energy, however we used the wind to generate energy for the building.

Throughout this project we faced minor limitation. These limitation were in the calculations that we used as some of them did not turn out to be accurate and as a result the entire process had to be repeated in order to acquire the right calculations.

The goals of the project are: to decrease the demand of electricity on the power station throughout the day, to decrease the pollution done by the power station through using alternative energy -like the sun and wind in our case, Furthermore, our system will satisfy two credits from the Leadership in Energy and Environmental Design (LEED) green building rating system, namely, E.A. 6 and EQ 8.1. The first rates the building usage of green energy and the second mandates the utilization of at least 75% of sunlight to illuminate the building during daytime.

We want to acknowledge all of Dr. Ahmed BoShehri for being our supervisor in this project, Dr. Abdul-Aziz AlRashed for teaching us about the fiber optics, Dr.Mohammad BoShehri for helping us in the design of the blades, Eng. Ahmed ALSafi for giving us the wind reading from the civil aviation, and Dawood AlBader for giving us information about the LEED certificate.

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